[SPECIFICATIONS]

[NAME OF INVENTION]

TFT array panel and a Liquid crystal display device

[BRIEF EXPLANATION OF FIGURES]

FIG. 1 is a cross-sectional view showing a cross-section corresponding to one pixel region of a liquid crystal display device according to the related art;

FIG. 2 is a cross-sectional view showing a cross-section corresponding to one pixel region of an IPS mode liquid crystal display device according to the related art;

FIGs. 3a and 3b are perspective views showing an operation of an IPS mode liquid crystal display device according to the related art;

FIG. 4 is a plan view showing an IPS mode liquid crystal display device according to the related art;

FIG. 5 is an expanded plan view of an A portion of FIG. 4;

FIG. 6 is an expanded plan view showing a portion of a common electrode and a pixel electrode of an IPS mode liquid crystal display device according to the present invention;

FIG. 7 is a plan view showing a portion of a common electrode and a pixel electrode portion of another embodiment of an IPS mode liquid crystal display device according to the present invention;

* Explanation of major parts in the figures *

200 : common electrode 300 : pixel electrode

250a : indentation 250b : protrusion

[DETAILED DESCRIPTION OF INVENTION]

[OBJECT OF INVENTION]

[TECHNICAL FIELD OF THE INVENTION AND PRIOR ART OF THE FIELD]

The present invention relates to a picture image device, and more particularly, to a liquid crystal display device having a thin film transistor and a method of fabricating the same.

Especially, the present invention does not relate to a conventional mode LCD device such that the common electrode is formed on a color filter substrate, but it relates to an In-Plane Switching (IPS) mode LCD device such that a common electrode is formed on the same substrate, which includes a thin film transistor, as a pixel electrode. Further, the present invention relates to a reduction of manufacturing process.

Generally, the LCD is driven by an optical anisotropy and spontaneous polarization of the liquid crystal. Since the liquid crystal is thin and long, it has a direction in an arrangement of the liquid crystal molecule. Further, the direction of the molecule arrangement can be controlled by artificially applying electric field to the liquid crystal.

Accordingly, when the direction of the liquid crystal molecule arrangement is specifically controlled, it is changed. Therefore, light is reflected along the direction of the liquid crystal molecule arrangement due to the optical anisotropy so that a picture image information can be represented.

Presently, an active matrix LCD having the thin film transistor and a pixel electrode connected to the thin film transistor are arranged with a matrix type are most noticed because embodiment ability of resolution and moving image are excellent.

Generally, the configuration of the liquid crystal display panel such as basic element comprising the liquid crystal display device will be set forth as follows.

FIG. 1 is a cross-sectional view showing a cross-section of a liquid crystal display device according to the related art.

A liquid crystal display panel 20 includes two substrates 2 and 4 formed a plurality of elements and attached to each other, and a liquid crystal layer 10 attached between the two substrates 2 and 4.

The liquid crystal display panel 20 includes an upper substrate 4 formed a color filter layer 8 displaying a color and a lower substrate 2 having within a switching element that can change the arrangement direction of the liquid crystal layer 10.

The color filter layer 8 embodying a color and a common electrode 12 covering the color filter layer 8 are formed on the upper substrate 4. The common electrode 12 has a role of one side electrode applying a voltage to the liquid crystal layer 10. The lower substrate 2 includes a thin film transistor S acting as the switching element and a pixel electrode 14 acting as the other side electrode applied a signal from the thin film transistor S and applying a voltage to the liquid crystal layer 10.

A portion including the pixel electrode 14 refers to a pixel region P.

In addition, to prevent the liquid crystal layer 10 injected between the upper and lower substrates 2 and 4 from leaking, the edge of the upper and lower substrates 2 and 4 is attached with a sealant 6.

The plurality of thin film transistors S and the plurality of pixel electrodes 14 connected to the plurality of thin film transistors S are arranged on the lower substrate 2, respectively.

The LCD device has a configuration such that a common electrode is formed on a color filter substrate or upper substrate. For instance, as an LCD device having the configuration such that a common electrode is formed along a perpendicular with a pixel electrode drives a liquid crystal by a vertical electric filed between a upper electrode such as the common electrode and a lower electrode such as the pixel electrode, for example, transmittance and aperture ration are excellent. Further, because the common electrode has a role of grounding connection, the LCD device can be prevented the liquid crystal cell from destruction due to static electricity.

However, the LCD device having the liquid crystal driven by the vertical electric field has a disadvantage that characteristic of viewing angle is not excellent. Therefore, to overcome the disadvantage, a new technology is suggested. Hereinafter, a contents that will be described has an advantage such that characteristic of viewing angle is excellent by using a method of driving the liquid crystal through a horizontal electric field.

Hereinafter, referring to FIG. 2, an IPS mode LCD device according to the related art will be explained in detail.

A pixel electrode 34 and a common electrode 36 are formed on the same plan of a substrate 30. For instance, a liquid crystal layer 10 is driven by a horizontal electric field 35 between the pixel electrode 34 and the common electrode 36 on the substrate 30. A color filter substrate 32 is formed on the liquid crystal layer 10.

FIGs. 3a and 3b are views showing a phase change of a liquid crystal by on/off states voltage of an IPS mode LCD device according to the related art.

As show in FIG. 3a, a phase change is not occur when the horizontal electric field 35 is not applied to the pixel electrode 34 and the common electrode 36.

FIG. 3b is a view showing a phase change of a liquid crystal when a voltage is applied to the pixel electrode 34 and the common electrode 36.

As explained above, the IPS mode LCD device has a characteristic such that the horizontal electric field 35 is utilized because the pixel electrode and the common electrode coexist on the same plan.

In addition, a transparent electrode is not utilized on the color filter substrate, a liquid crystal for the IPS mode LCD device corresponds to a liquid crystal having a negative induced electricity anisotropy.

It is possible that a wide viewing angle is embodied as an advantage of the IPS mode. Accordingly, when a user sees the LCD device at the front side, the user can see in about 70° direction for top/bottom/left/right direction. In addition, the IPS mode LCD device has an advantage such that a manufacturing process is simpler than the LCD device according to the related art and a color conversion due to a change of the viewing angle is small.

However, because the common electrode 36 and the pixel electrode 34 exist on a same substrate, there is a disadvantage that transmittance and aperture ratio for light of a lower light source are reduced. Further, there are disadvantage that response time by a driving voltage should be improved and a cell gap should be uniform because a misalign margin of the cell gap has a limitation.

As explained above, the IPS mode has all of the advantage and the disadvantage, and it can be utilized by a choice according to uses of a user.

A content that will be described corresponds to a manufacturing process of the IPS mode LCD device.

FIG. 4 is a plan view showing an IPS mode liquid crystal display device according to the related art.

As shown in FIG. 4, a gate line 50 and a common line 54, which are in horizontal with each other, are formed along a transverse direction and a data line 60 is in perpendicular with the gate and the common lines 50 and 54 along a columnar direction.

In addition, a gate electrode 52 is formed on a side of the gate line 50, a source electrode 62 that is extended to the data line 60 and is located in adjacent to the gate electrode 52 overlaps a portion of the gate electrode 52, and a drain electrode 64 is formed corresponding to the source electrode 62.

Additionally, the common line 54 includes a plurality of common electrodes 54a diverged from the common line 54, an extended line 66 is connected to the drain electrode 64, and the extended line 66 includes a plurality pixel electrodes 66a diverged from the extended line 66. The common electrode 54a and the pixel electrode 66a are formed alternately with each other.

[TECHNICAL SUBJECT OF INVENTION]

The mentioned IPS mode LCD device has a big disadvantage such that an aperture ration goes down by coexisting the pixel electrode 66a and the common electrode 54a on the lower substrate having the thin film transistor.

To solve this problem, as shown in FIG. 5 as an expanded plan view of A portion of FIG. 4, the aperture ratio problem may be solved by increasing the distance between the pixel electrode 66a and the common electrode 54a. However, when the distance between the pixel electrode 66a and the common electrode 54a is increased, there is a disadvantage that a threshold voltage V_{Th} becomes larger than a predetermined value for driving the liquid crystal of the IPS mode.

At this time, L is defined as a distance between the pixel electrode 66a and the common electrode 54a, and d is defined as a line width of respective electrodes.

The threshold voltage V_{Th} has a close relationship with the distance L and the line width d between electrodes 66a and 54a, hereinafter.

$V_{Th} \propto L/d$ - - - - - - - (1)

As illustrated above, the relationship between the threshold, the distance and the line width can be shown.

Accordingly, as shown in form (1), there is a tendency that the more the distance L between the electrodes 66a and 54a is large, the more the threshold increase. It is because that the distance L increase as an intensity of electricity field between both of the electrodes 66a and 54a reduces.

Such the problem can be solved by increasing the intensity of electric field through increasing the driving voltage, but the driving voltage of a driving circuit utilized for driving respective electrodes 66a and 54a has a limitation due to a small value.

By increasing the distance L between the pixel electrode 66a and the common electrode 54a in the IPS mode LCD device, an aperture ratio is increased and brightness can be improved. However, there is a problem such that all of the driving voltage and the distance L between the electrodes cannot be satisfied by the method.

To solve the problem of the IPS mode LCD device according to the related art, the present invention has an object to provide an IPS mode LCD device that an aperture ratio can be improved and the driving voltage can have a small value.

[CONSTRUCTION AND OPERATION OF INVENTION]

To achieve the objectives of the present invention, an array panel having a thin film transistor includes: a substrate; a thin film transistor formed on the substrate; first and second lines crossing each other, the first and second lines connected to the thin film transistor; a pixel electrode substantially having a zigzag shape including a plurality of indentations and a plurality of protrusions extended along the same direction as the second line, the pixel electrode supplied a signal from the thin film transistor, the pixel electrode substantially extended along a horizontal direction with the first line; a common electrode having the same shape as the pixel electrode including the zigzag shape, the common electrode substantially in parallel with the pixel electrode.

The indentation and the protrusion are substantially square shapes, and a portion of the common electrode corresponding to the protrusion of the pixel electrode includes a indentation.

In another aspect, a liquid crystal display device includes: first and second substrates; a liquid crystal interposed between the first and second substrates; a first electrode formed on the first substrate along a first direction, the first electrode applying a voltage to the liquid crystal; a second electrode formed on the first substrate substantially in parallel with the first electrode and earthed with outside, the second electrode substantially having a zigzag shape including a indentation and a protrusion formed along the same direction as the first electrode; a switching element applying a signal to the first electrode.

The first electrode has the same shape as the second electrode.

Hereinafter, the present invention will be explained in detail referring to attached drawings.

As FIG. 6 is a plan view showing a plan of a pixel region including a common electrode 200 and a pixel electrode 300 of an IPS mode LCD device according to the present invention, a main characteristic of the IPS mode LCD device according to the present invention corresponds to a shape of the common electrode 200 and the pixel electrode 300.

Particularly, through the common electrode and the pixel electrode according to the related art are parallel with each other and have straight line - shapes, but the common electrode 200 and the pixel electrode 300 have zigzag shapes according to the IPS mode LCD device of the present invention, respectively.

More particularly, for example, the pixel electrode 300 includes an indentation 250a and a protrusion 250b that are formed in repeatedly order in one side of the pixel electrode 300, and the other side facing the one side includes the protrusion 250b.

Meanwhile, the common electrode 200 has the same shape as the pixel electrode 300, and the other side of the pixel electrode 300 facing and corresponding to the one side of the common electrode 200 sequentially formed the indentation 250a and the protrusion 250b includes the protrusion 250b and the indentation 250a, conversely. The indentation 250a and the protrusion 250b substantially have square shapes, respectively.

In other words, a portion of the pixel electrode 300 facing and corresponding to a portion including the protrusion 250b of the common electrode 200 includes the indentation 250a.

When the common electrode 200 and the pixel electrode 300 are formed as explained above, a distance d1 between the protrusions 250b of the common electrode 200 and the pixel electrode 300 is shorter than the distance L between the common electrode and the pixel electrode according to the IPS mode LCD device of the related art. Therefore, effects such that the intensity of electric field increase can be obtained by being close the distance d1 in

comparison with the distance L. At this time, d2 shows a distance between the indentation 250a and the protrusion 250b.

Accordingly, the driving voltage can be lowered, thereby manufacturing an IPS mode LCD device that its power consumption can be reduced.

Although the mentioned above, the driving voltage and the distance between the common electrode and the pixel electrode are proportional to each other. Specifically, the more the distance between the electrodes is long, the more the driving voltage for driving the liquid crystal increases.

In other words, when the distance between the electrodes increases, the aperture ratio can be increased. Accordingly, while brightness can be improved, there is a disadvantage that the driving voltage increases.

Conversely, when the distance between the electrodes is shorted to reduce the driving voltage, the aperture ratio rapidly become reduced, relatively. Therefore, brightness more than 200 nit as a brightness of an LCD device generally demanded cannot be obtained.

However, recent consumers demand large size and high resolution model LCD device, recently, obtaining the aperture ratio becomes more difficult in this case. It is because that the more the panel size and the resolution of the LCD device increase, the less a size of the pixel region is small.

Consequently, though the IPS mode LCD device should be utilized to embody a wide viewing angle, there is a disadvantage that it is difficult that the high resolution is embodied due to characteristic of the configuration of the electrodes.

To embody the mentioned wide viewing angle and high resolution LCD device, the present invention provides the common electrode 200 and the pixel electrode 300 having zigzag shapes that includes the indentation 250a and the protrusion 250b, thereby obtaining a

desired aperture ration by sufficiently increasing the distance between the common electrode 200 and the pixel electrode 300. Further, the present invention has another advantage that can be sufficiently lowered the driving voltage by the protrusion 250b formed respective electrodes 200 and 300.

Specifically, the common electrode 200 and the pixel electrode 300 include chrome (Cr), aluminum (Al), aluminum alloy, molybdenum (Mo), tantalum (Ta), tungsten (W), antimony (Sb), indium tin oxide (ITO) and indium zinc oxide (IZO).

FIG. 7 is a view showing the other embodiment according to the present invention, wherein an indentation 250a and a protrusion 250b are formed as trapezoid shapes.

However, there is no limitation that the shapes of the indentation and the protrusion is modified, for example, the indentation and the protrusion may have triangle shapes.

[EFFECT OF INVENTION]

When an IPS mode LCD device is manufactured according to embodiments of the present invention, there is an advantage that the driving voltage can be lowered by being high the intensity of electric field between respective electrodes by forming the side portion of the common electrode and the pixel electrode as the zigzag shapes including the indentation and the protrusion-though the distance between the common electrode and the pixel electrode is sufficiently long.